



RESEARCH PAPER

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Spatial Pattern Analysis of Crop Concentration and Crop Diversification for Sustainable Agriculture in Kaimur District, Bihar, India

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Abstract

Agriculture remains the primary livelihood for over half of India's population. In Bihar, Kaimur district exemplifies this dependency, with its economy predominantly driven by agriculture. For sustainable agricultural planning and policy-making, it is essential to understand the patterns of crop concentration and diversification in the region. The primary objective of this study was to investigate crop concentration and diversification in Kaimur District for the period 2024–2025. The study employed Bhatia's method to evaluate the level of crop concentration and the Gibbs-Martin index to assess the extent of crop diversification. The study utilises secondary data obtained from the District Agriculture Department, Bhabua. Data is analysed using statistical software to compute indices and interpret the findings. Preliminary analysis indicates distinct spatial variations in crop concentration and diversification in the Kaimur district. Rice shows the highest concentration in Bhagwanpur (1.18) and the lowest in Nuaon (0.92) and Ramgarh (0.92). Wheat dominates in Kudra (1.17) and Bhabua (1.12), reflecting canal-fed cereal specialisation. Barley displays exceptional concentration in Nuaon (3.78) and Chainpur (1.63). Pulses and oilseeds show the highest concentrations in Adhaura (Gram-2.34, Lentil-4.50, Peas-3.61, Mustard-1.60, and Linseed-9.10), highlighting adaptive diversification in rainfed uplands. The spatial pattern of the Crop Diversification Index (CDI) ranges from 0.49 (Bhagwanpur) to 0.61 (Adhaura and Chand). Diversification appears limited, as evidenced by a low Gibbs-Martin index, suggesting a reliance on a narrow range of crops. The findings emphasise the need for strategies to encourage crop diversification in the Kaimur district. To enhance sustainability, policy interventions should target low CDI blocks (<0.55) by promoting pulses, oilseeds under integrated schemes. Recommendations include the introduction of high-value crops, improving irrigation infrastructure, and providing market linkages to encourage farmers to adopt diversified cropping systems. Such measures could enhance agricultural sustainability and economic resilience in the region.

Keywords: Crop Concentration; Crop Diversification; Cropping Pattern; Kaimur District; Sustainable Agriculture; Climate-Smart Agriculture

Introduction

Agriculture continues to be the foundation of India's rural economy and social structure, providing livelihoods to more than half of the population and contributing significantly to food security and economic growth. Despite advancements in industry and services, agriculture remains indispensable for sustaining rural livelihoods and ensuring national food sufficiency (Kumar & Ravindra Nath, 2023). However, the sector faces mounting challenges due to climate change, land degradation, resource scarcity, and market volatility (Kumar et al., 2024).

To mitigate these challenges, Climate-Smart Agriculture (CSA) has emerged as a strategic framework for promoting climate adaptation and sustainable intensification in agriculture (Manda



et al., 2016). CSA integrates multiple sustainable agricultural practices such as crop diversification, conservation tillage, agroforestry, integrated nutrient and pest management, water harvesting, and cultivation of drought-tolerant crop varieties (Faurès et al., 2013; Makate et al., 2016). The development of resilient agricultural systems is particularly vital in regions where households depend heavily on ecosystem services such as food, fodder, and fuel for their livelihoods (Lin, 2011). Crop diversification is increasingly recognised as a key strategy for achieving agricultural sustainability (Baruah et al., 2020). From a sustainability perspective, diversification enhances the resilience of agroecosystems by improving soil fertility, promoting biodiversity, and optimising resource use (Gawdiya et al., 2025).

Crop diversification aligns closely with the three pillars of sustainability:

- **Environmental Sustainability:** Diversified systems contribute to ecological balance by improving soil structure, reducing pest incidence, conserving water, and enhancing nutrient cycling (Mihrete & Mihretu, 2025).
- **Economic Sustainability:** Crop diversification spreads production risk, stabilises farm income, and enables farmers to access multiple markets by cultivating high-value or climate-resilient crops (Adjimoti & Kwadzo, 2018).
- **Social Sustainability:** It ensures food and nutritional security through a diversified food basket and supports employment opportunities in rural areas (Gebiso et al., 2023).

Thus, crop diversification supports the transition towards climate-resilient and sustainable agricultural systems. It directly contributes to the achievement of the Sustainable Development Goals, SDG 2 (Zero Hunger) and SDG 13 (Climate Action). In addition, diversification encourages more balanced nutrient extraction and reduces environmental footprints. It enhances farmers' adaptive capacities to climate shocks (Kumar & Babu, 2025; Fan et al., 2025).

Globally, studies have demonstrated that crop diversification contributes to yield stability, ecological resilience, and improved resource efficiency. For instance, diversified cropping systems have shown positive effects on soil nitrogen dynamics, pest regulation, and water-use efficiency (Osterholz et al., 2018; Lin, 2011). In Africa and Latin America, diversification has been associated with greater livelihood stability and adaptability to intra-seasonal climate variability (Makate et al., 2016). In India, studies indicate substantial variation across states and districts. For example, in West Bengal, districts such as Malda and Birbhum remain dominated by rice monoculture, with limited diversification (Ganguly & Patra, 2015). Similarly, diversification patterns in Uttar Pradesh and Andhra Pradesh are shaped by variations in irrigation intensity, mechanisation, and market connectivity (Kumar & Singh, 2020; Ankanna & Kumari, 2019). Collectively, these studies reveal a complex interplay between environmental and economic drivers of crop diversification in India. Diversification enhances resilience and long-term sustainability. Regions with high crop concentration remain vulnerable to climatic shocks, market risks, and resource degradation.

Despite the extensive research on crop concentration and diversification, most of the studies have focused on macro-level analyses with limited attention to intra-district variations that are critical for local agricultural planning and sustainable resource management. Moreover, few attempts have been made to integrate geospatial analytical techniques with quantitative indices such as the Crop Concentration Index and the Crop Diversification Index with a sustainability framework to map spatial disparities at the block level. The block-level spatial patterns of crop concentration and diversification remain unexplored in Kaimur. The study area offers a unique geographical and ecological setting, such as topography, irrigation availability, and soil types. The region's dependence on agriculture, combined with varying degrees of resource endowment, makes it an ideal case for studying the spatial heterogeneity of cropping systems. The present study addresses this critical research gap by employing geospatial and statistical techniques. The objective of this study was to analyse the spatial pattern of crop concentration and diversification at the block level in Kaimur for the agricultural year 2024-25.

Study Area

Kaimur district is located in the extreme southwestern part of Bihar, situated between 24° 0' 13" N to 25° 0' 24" N latitude and 83° 0' 19" E to 83° 0' 51" E longitude. It ranks 32nd in terms of population, with 1,662,384 people, and 6th in terms of area, covering 3,362 square kilometres, in the state of Bihar (DCHB Kaimur, 2011). Geographically, the district can be divided into two main regions. The northern part features a flat alluvial plain. In contrast, the southern part is characterised by the Kaimur Plateau. The climate of the district is quite extreme, featuring hot summers and relatively cold winters. January experiences the lowest temperature, with the average minimum dropping to

around 4°C. Starting in March, temperature begin to increase, peaking in May when they approach approximately 45°C (District Survey Report, 2018). Rainfall begins in mid-June with the onset of the southwest monsoon. The average rainfall in Kaimur district is 837.5 mm, with approximately 80% of the rainfall occurring from mid-June to September. The district experiences an average of 36.4 rainy days (Aquifer Mapping Report on Kaimur District, 2018-19). In terms of drainage, the district is divided into two parts; the western part forms the catchment area of the Karamnasa River, while the Durgawati River drains the eastern part. The Sone River, which flows from west to east through the southern part of the district, does not significantly influence the river system in the area (District Survey Report, Kaimur, 2018).

Agriculture is the primary livelihood for most of the district's population. The district shows significant variation in crop production, which depends on factors such as land surface type, soil quality, irrigation facilities, and other conditions. Kaimur is known for its cultivation of both Kharif and Rabi crops. During the Kharif season, **rice** dominates, especially in the plain areas, due to favourable irrigation facilities and fertile soils. In the Rabi season, crops such as wheat, gram, peas, lentil, mustard, and oilseed are cultivated. Among the Rabi crops, wheat is the most important in nearly all areas (Kumari, 2021).

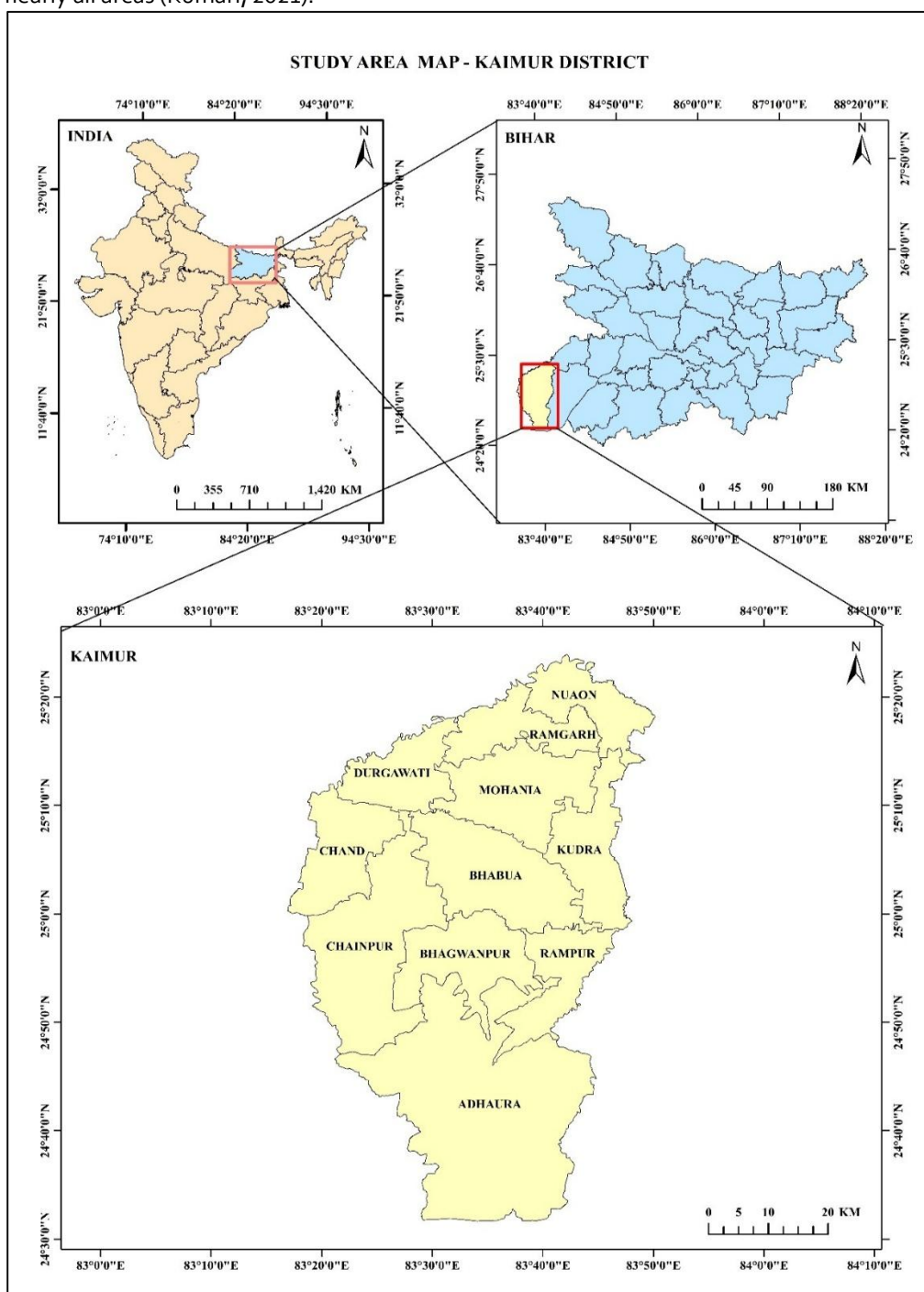


Fig.1. Location Map Kaimur District, Bihar, India

Materials and methods

The present study utilises a combination of spatial mapping techniques and quantitative data analysis to examine the block-wise patterns of crop concentration and crop diversification in the district. To facilitate this analysis, eight major crops (Rice, Wheat, Barley, Gram, Lentil, Peas, Mustard, and Linseed) have been selected because these crops collectively represent the dominant cropping system in the district and have reliable secondary data available for all blocks. The selected crops provide a balanced representation of the cereal-pulse-oilseed production system.

Materials

The present research work is based on secondary data collected through the District Agriculture Department, Bhabua, Kaimur District, Bihar.

Methods

Crop Concentration

To examine the crop concentration index at the block level and its regional variations, Bhatia's Location Quotient Method was used. The crop concentration index is as follows:

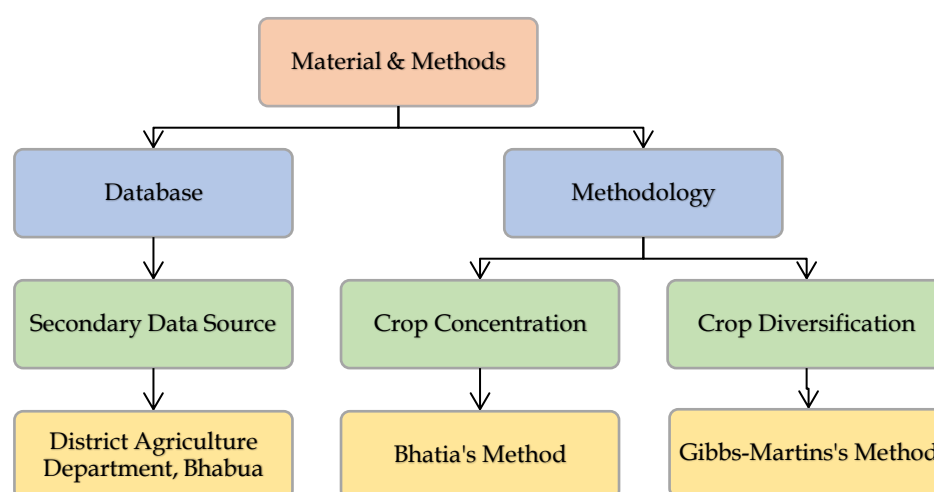


Fig.2. Framework of Materials and Methods

Crop Concentration Index (CCI)

$$\text{Crop Concentration Index (CCI)} = \frac{c_{ij}/c_j}{c_i/C}$$

where,

- c_{ij} - Area of x crop in the unit area
- c_j - Area of all crops in the unit area
- c_i - Area of x in the entire region
- C - Area of all crops in the entire region

According to this method, a high index value represents a higher level of concentration of a particular crop, and a low index value represents a lower level of concentration of the crop.

Crop Diversification

To analyse crop diversification, Gibbs-Martin's Index has been applied, introduced by Gibbs et al. (1962), and is expressed as follows:

$$\text{Crop Diversification Index (CDI)} = 1 - \frac{\sum X^2}{(\sum X)^2}$$

Where,

- X = Percentage of total cropped area occupied by an individual crop

According to this technique, crop diversification varies from 0.1 to 0.9. A higher index value indicates greater crop diversification, while a lower value reflects limited diversification. If the index comes closer to 1, that means the diversification will be higher.

To facilitate a detailed comparative assessment, Microsoft Excel 2021 was employed for data tabulation, statistical calculations, and the generation of preliminary graphs and tables. Advanced spatial analysis and thematic mapping have been prepared using ArcGIS 10.3, enabling the visualisation of crop concentration and diversification patterns at the block level. Standard indices such as Crop Concentration Index (CCI) and Crop Diversification Index (CDI) were computed to quantify the degree of crop concentration and diversification. These indices provided a comprehensive approach for identifying areas with specialised versus diversified cropping patterns. The methodological approach integrates both quantitative and geospatial techniques to ensure a comprehensive understanding of spatial variations.

Results and Discussion

Crop Concentration

The crop concentration index expresses the proportion of area under each crop relative to the total cropped area in each block. A higher percentage indicates a greater concentration of that crop. Identifying areas with high crop concentration helps to determine where certain crops can grow well, even with minimal resources. This is important for agricultural planning and development (Baruah et al., 2020).

Table 1. Block-wise Crop Concentration Index (CCI) in Kaimur District, 2024-25

S. No.	Blocks	Rice	Wheat	Barley	Gram	Lentil	Peas	Mustard	Linseed
1	Adhaura	1.05	0.54	0.61	2.34	4.50	3.61	1.60	9.10
2	Bhabua	0.95	1.12	0.79	0.53	0.57	0.88	0.85	0.74
3	Bhagwanpur	1.18	0.79	0.56	0.67	0.78	0.87	0.87	0.84
4	Chainpur	0.99	0.95	1.63	0.95	1.16	1.72	1.60	1.41
5	Chand	0.93	0.91	1.15	2.12	3.25	0.59	0.97	1.69
6	Durgawati	1.03	0.92	0.37	1.49	0.81	0.79	1.16	0.39
7	Kudra	0.94	1.17	0.31	0.42	0.34	0.52	0.63	0.56
8	Mohania	1.08	0.84	1.20	1.35	1.38	0.80	0.69	0.85
9	Nuaon	0.92	1.10	3.78	0.85	0.54	1.59	1.11	0.64
10	Ramgarh	0.92	1.10	0.67	1.14	0.60	1.04	1.12	0.66
11	Rampur	0.99	1.04	0.15	0.90	0.47	0.78	1.23	0.66

Source: Computed by Authors

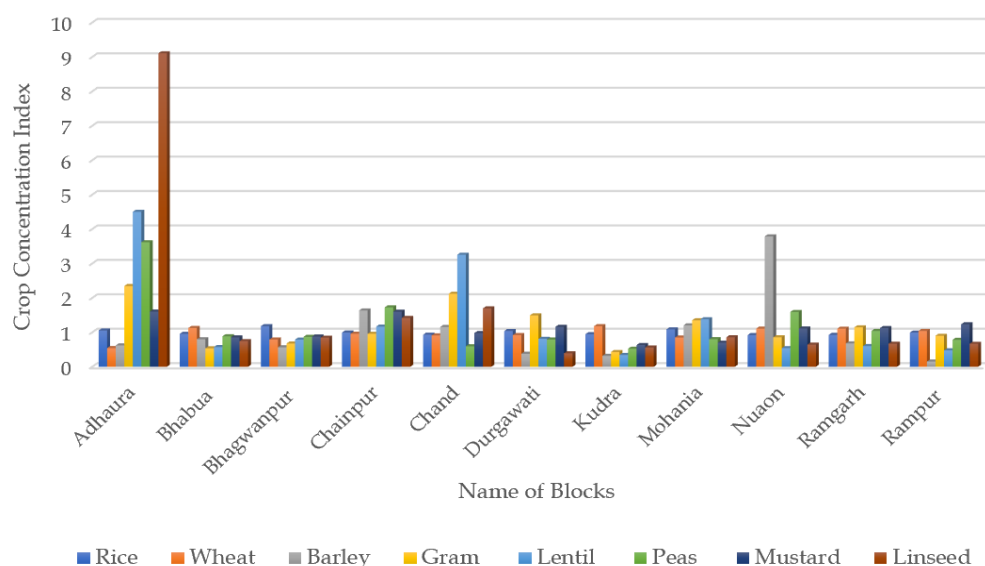


Fig. 3. Block-wise Crop Concentration Index in Kaimur District

Spatial Pattern of Crop Concentration

Rice

The total cultivated area of Rice in the district for the given year is about 141,392.54 hectares, which makes up 54.23% of the total cropped area. According to the crop concentration index, Rice exhibits

the highest concentration in one block, Bhagwanpur (1.18), medium concentration in five blocks, namely, Mohania (1.08), Adhaura (1.05), Durgawati (1.03), Chainpur (0.99), and Rampur (0.99), and low concentration in five blocks, namely, Bhabua (0.95) and Kudra (0.94), Chand (0.93), Nuaon (0.92), and Ramgarh (0.92). Overall, rice remains the most uniformly cultivated crop across the district with mild regional fluctuations. The crop concentration distribution is shown in Fig. 4 (A) and Table 1.

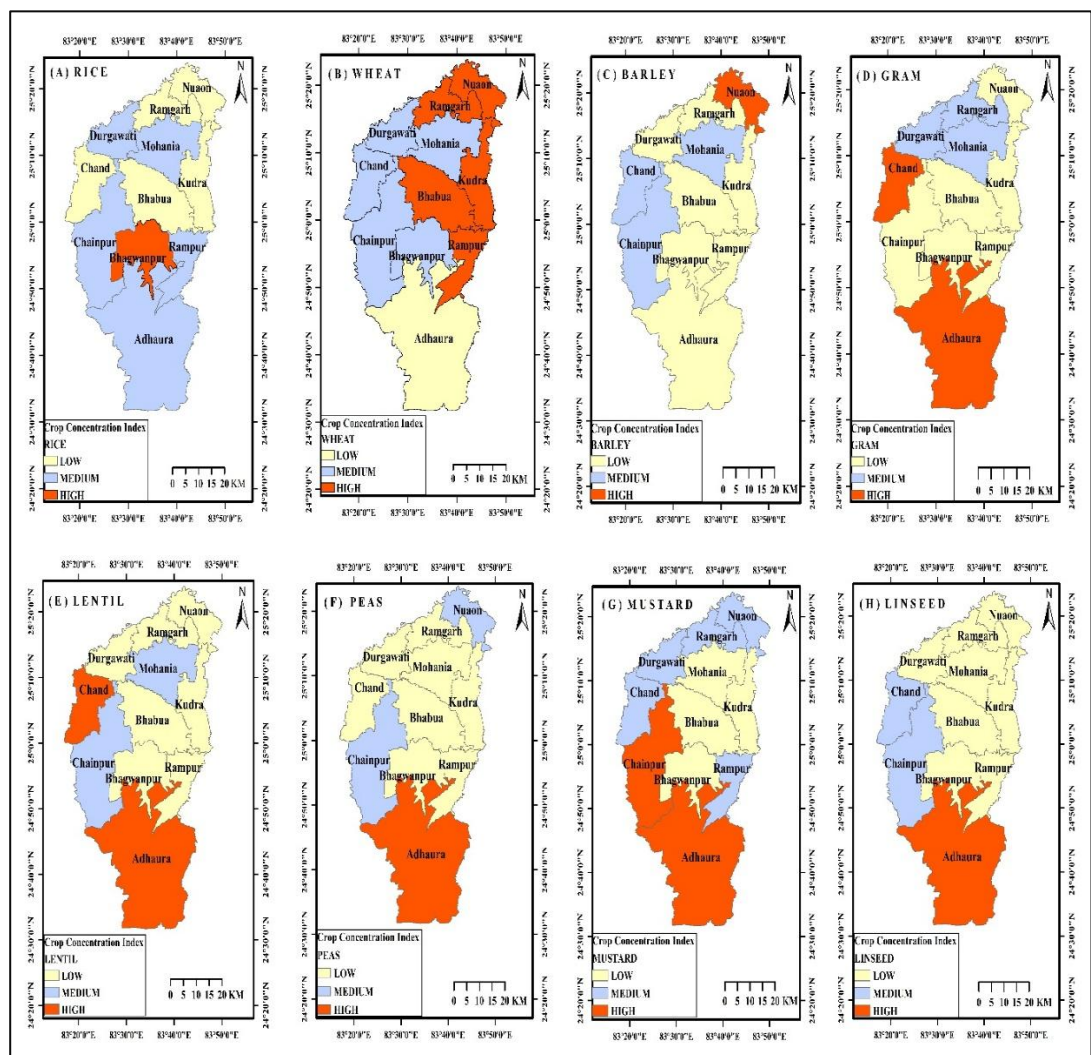


Fig. 4. Block-wise Crop Concentration Index in Kaimur District

Wheat

The total area used for wheat cultivation is 100,603 hectares, which makes up 36.87% of the overall cultivated area. The concentration index shows that wheat has a high concentration in five blocks, namely, Kudra (1.17), Bhabua (1.12), Ramgarh (1.10), Nuaon (1.10), and Rampur (1.04). These blocks are typically located in areas with suitable irrigation and fertile soils, favouring wheat production. In contrast, wheat concentration is medium in the Chainpur (0.95), Durgawati (0.92), Chand (0.91), Mohania (0.84), and Bhagwanpur (0.79). The lowest wheat concentration is in the southernmost block, Adhaura (0.54), possibly due to terrain and limited irrigation facilities. The data suggests a strong cereal-based cropping system in the central and western blocks of the district. The spatial distribution of wheat crop concentration is shown in Fig. 4 (B) and Table 1.

Barley

The total area used for barley cultivation is about 787 hectares, which makes up 0.30% of the total cropped area. The crop concentration index shows high concentration in one block, namely, Nuaon (3.78), medium concentration in three blocks, namely, Chainpur (1.63), Mohania (1.20), and Chand (1.15), and low concentration in seven blocks, namely, Bhabua (0.79), Ramgarh (0.67), Adhaura (0.61), Bhagwanpur (0.56), Durgawati (0.37), Kudra (0.31), and Rampur (0.15). The exceptionally high CCI in Nuaon suggests a localised adaptation or preference for barley, possibly due to agronomic or socio-economic factors. Despite being a minor crop in total area, barley shows localised intensity in certain blocks. The spatial distribution of barley crop concentration is shown in Fig. 4 (C) and Table 1.

Gram

The total area dedicated to gram cultivation is approximately 7,860 hectares, making up 3.50% of the total cultivated land in the district. The concentration index shows that gram cultivation has a high concentration in two blocks namely, Adhaura (2.34) and Chand (2.12), highlighting their importance as pulses-growing regions, likely in areas with lower water availability, medium concentration in three blocks namely, Durgawati (1.49), Mohania (1.35), Ramgarh (1.14) and a low concentration in six blocks namely Chainpur (0.95), Rampur (0.90), Nuaon (0.85), Bhagwanpur (0.67), Bhabua (0.53), Kudra (0.42) reflect minimal gram concentration, reinforcing their emphasis on cereals. The spatial distribution of gram crop concentration is shown in Fig. 4 (D) and Table 1.

Lentil

The total area used for lentil cultivation is 4,230.5 hectares, making up 2.12% of the overall cultivated land in the district. Spatial analysis reveals that the highest concentration of lentil is found in the southernmost block, Adhaura (4.50), and the western block, Chand (3.25), suggesting these blocks are highly pulse-oriented in their cropping system. On the other hand, the northern block of Mohania (1.38) and the western block of Chainpur (1.16) show a moderate concentration of lentil cultivation. In contrast, Durgawati (0.81), Bhagwanpur (0.78), Ramgarh (0.60), Bhabua (0.57), Nuaon (0.54), Rampur (0.47), and Kudra (0.34) blocks of the district have a low concentration of lentil cultivation. The spatial distribution of lentil crop concentration is shown in Fig. 4 (E) and in Table 1.

Peas

The total area used for pea cultivation in the study region is approximately 1,456 hectares, which accounts for 0.66% of the total cultivated area. Spatial analysis further reveals that pea cultivation is highly concentrated in the southernmost block, Adhaura (3.61), of the district; a moderate concentration of pea cultivation is found in the Chainpur (1.72) and Nuaon (1.59) blocks, and a low concentration in Ramgarh, Durgawati, Chand, Mohania, Bhabua, Kudra, Rampur, and Bhagwanpur blocks of the district. The spatial distribution of pea crop concentration is shown in Fig. 4 (F) and Table 1.

Mustard

The total area used for mustard cultivation is 4,275.5 hectares, accounting for 1.76% of the overall cultivated area. Spatial analysis indicates that the southernmost block, Adhaura (1.60), and the southwestern blocks, Chainpur (1.60) have a high concentration of mustard cultivation, while Rampur (1.23), Durgawati (1.16), Ramgarh (1.12), Nuaon (1.11), Chand (0.97) have a moderate concentration and Bhagwanpur (0.87), Bhabua (0.85), Mohania (0.69), and Kudra (0.63) blocks have a low concentration. The spatial distribution of mustard crop concentration is shown in Fig. 4 (G) and Table 1.

Linseed

The total area used for linseed cultivation is 840.7 hectares, which accounts for 0.51% of the total cropped area. Specifically, the southernmost blocks Adhaura (9.10) of the district show the highest concentration of linseed cultivation, while the western blocks Chand (1.69) and Chainpur (1.41) exhibit a medium concentration. In contrast, central blocks Mohania (0.85) and Bhabua (0.74), southern block Bhagwanpur (0.84), south eastern blocks Rampur (0.66), northern blocks Ramgarh (0.66) and Nuaon (0.64), eastern blocks Kudra (0.56), northwestern block Durgawati (0.39), of the district have a low concentration of linseed cultivation. The spatial distribution of linseed crop concentration is shown in Fig. 4 (H) and in Table 1.

The district's spatial distribution of crop cultivation reveals a clear dichotomy between cereal-dominant regions and pulses/oilseed-focused blocks. Rice and wheat dominate the agricultural landscape of the district, both in terms of total cultivated area and their relatively even spatial distribution across most blocks. In contrast, pulses and oilseeds localised cultivation patterns, primarily concentrated in the southern and western upland regions, where irrigation is limited and the terrain is less favourable for water-intensive crops. Among these, Adhaura block consistently demonstrates a high concentration of pulses and oilseeds, suggesting a distinct cropping system influenced by its unique topography and constrained water availability. Mohania, Kudra, Bhabua, and Rampur emphasise cereal cultivation, reflecting their access to better irrigation infrastructure and more fertile soils. This spatial diversity in cropping patterns across the district underscores the potential for targeted, block-specific agricultural planning, enabling more efficient resource

allocation and tailored crop interventions to enhance overall productivity and sustainability in the district.

Crop Diversification

Crop diversification refers to the process of expanding the variety and ecotypes within a particular crop species, aiming to maximise both the production of primary agricultural products and value-added processed products, thereby enhancing farmers' income (Bradshaw et al., 2004). Crop diversification can also be viewed as a response to environmental factors, including climatic variability and change, at the farm level (Bradshaw et al., 2004; Baruah et al., 2020).

Table 2. Block-wise Crop Diversification Index (CDI) in Kaimur District, 2024-25

S. No.	Blocks	Crop Diversification Index
1	Adhaura	0.61
2	Bhabua	0.54
3	Bhagwanpur	0.49
4	Chainpur	0.57
5	Chand	0.61
6	Durgawati	0.55
7	Kudra	0.53
8	Mohania	0.54
9	Nuaon	0.56
10	Ramgarh	0.56
11	Rampur	0.54

Source: Computed by Authors

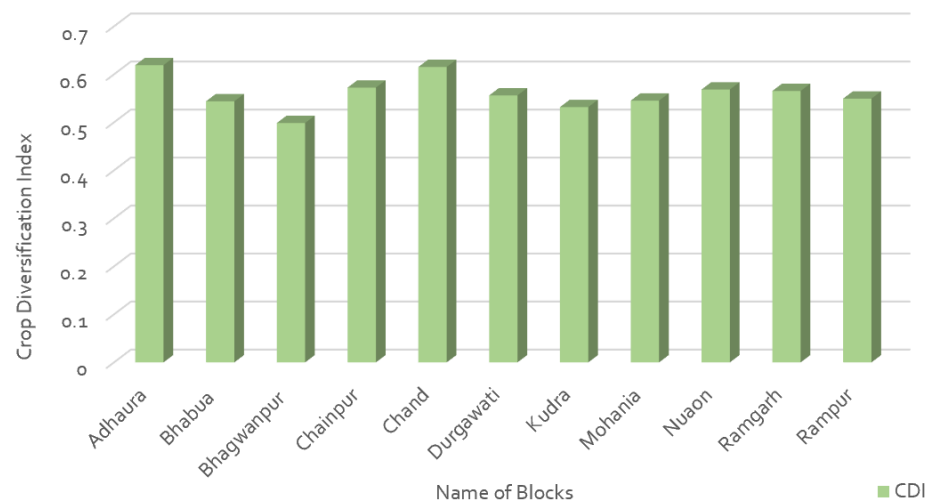


Fig.5. Block-wise Crop Diversification Index (CDI) in Kaimur District, 2024-25

Spatial Pattern of Crop Diversification

This study categorises crop diversification into three distinct levels: high, moderate, and low, based on index values derived from crop diversity metrics.

High Crop Diversification

A high level of crop diversification is observed in the Adhaura (0.61) and Chand (0.61) blocks. These areas exhibit a diversified cropping pattern, likely influenced by variations in topography, soil type, tribal populations and traditional agricultural practices may also contribute to a more diverse crop portfolio (Singh and Rai, 2017). The spatial distribution of high crop diversification is shown in Fig. 6 and Table 2.

Moderate Crop Diversification

Moderate levels of crop diversification are evident in the seven blocks, Nuaon (0.56), Ramgarh (0.56), Durgawati (0.55), Mohania (0.54), Bhabua (0.54), Chainpur (0.57), and Rampur (0.54). These blocks reflect intermediate diversity in cropping patterns. The spatial distribution suggests that agro-ecological and socio-economic conditions in these areas may support mixed cropping systems without full diversification. Fig. 6 and Table 2 provide detailed spatial representations of these patterns.

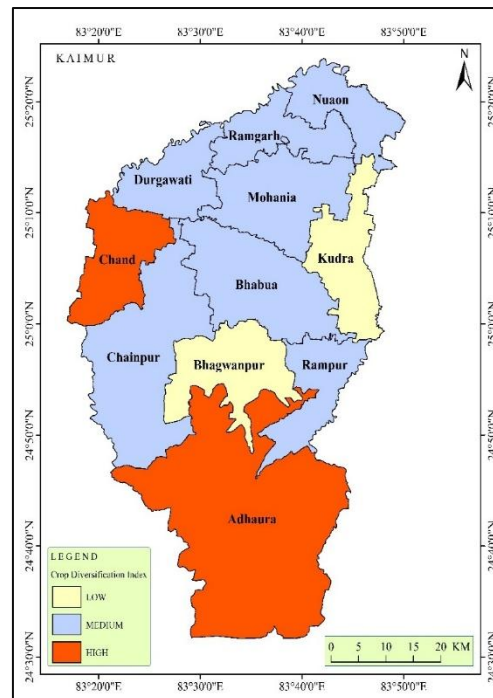


Fig.6. Block-wise Crop Diversification Index in Kaimur District

Low Crop Diversification

The lowest Crop Diversification Index is notably found in Kudra (0.53) and Bhagwanpur (0.49). These blocks are part of the intensive rice-wheat belt and have access to well-developed irrigation infrastructure, leading to a tendency toward monoculture or cereal-dominant systems. Market incentives and input support also contribute to reduced crop heterogeneity (Birthal et al., 2006). The spatial pattern of low crop diversification is presented in Fig. 6 and detailed in Table 2. The variation in CDI across the blocks of Kaimur district reflects the influence of geographical, climatic, and socio-economic factors. Higher diversification in blocks like Adhaura and Chand may be due to less favourable conditions for monoculture or better traditional knowledge of mixed cropping. On the other hand, lower CDI values in areas like Bhagwanpur and Kudra may reflect the dominance of high-yielding or commercially favourable crops like rice and wheat, encouraged by irrigation facilities and market access. Understanding these patterns is essential for formulating region-specific agricultural policies. Blocks with low diversification could be prioritised for diversification initiatives such as crop rotation awareness, market access for pulses and oilseeds, and support for climate-resilient crops.

Conclusion

The analysis of crop concentration and crop diversification across the eleven blocks in the Kaimur district for the agricultural year 2024–25 reveals considerable spatial differences influenced by agroecological, socio-economic, and infrastructural elements. The study identified a clear structural divide between the irrigated plains and the rainfed uplands using the Bhatia Crop Concentration Index and the Gibbs-Martin Crop Diversification Index. The crop concentration index demonstrates that rice and wheat dominate the district cropping pattern. The CCI for rice ranges from 0.92 in Nuaon and Ramgarh to 1.18 in Bhagwanpur, indicating the dominance of rice in the canal-fed northern plains. Wheat shows a similar pattern, with values ranging from 0.54 in Adhaura to 1.17 in Kudra, highlighting intensive wheat cultivation in the irrigated tracts and its limited spread in the rainfed uplands. Barley records a wide variation, ranging from a minimum of 0.15 in Rampur to a maximum of 3.78 in Nuaon, due to varied semi-arid conditions. Among pulses, Gram ranges from 0.42 in Kudra to 2.34 in Adhaura, while Lentil varies between 0.34 in Kudra and 4.50 in Adhaura. Similarly, Peas show values from 0.52 in Kudra to 3.61 in Adhaura, reaffirming the adaptation of pulse crops to the southern upland blocks. For oilseeds, Mustard ranges from 0.63 in Kudra to 1.60 in both Adhaura and Chainpur, while Linseed shows extreme spatial concentration, varying from 0.39 in Durgawati to 9.10 in Adhaura. These results indicate that Adhaura stands out as a diversification hotspot with varied ranges in pulses and oilseeds, while Bhagwanpur, Kudra, and Bhabua remain cereal-dominated blocks with high crop concentration and low diversification.

The crop diversification index across eleven blocks ranges from 0.49 (Bhagwanpur) to 0.61 (Adhaura and Chand), indicating low to high diversification. Most blocks exhibit low to moderate levels of

diversification, with rice and wheat as the primary crops. Only two blocks, Adhaura (0.61) and Chand (0.61), show a high diversification index. To address this imbalance, the study recommends block-specific diversification strategies. These findings underscore the need for targeted diversification policies to reduce over-dependence on cereal monocultures and enhance resilience. Diversification should be promoted through crop rotation and intercropping, investment in micro-irrigation, and creation of minor irrigation assets (check dams, tanks, percolation ponds). Enhancing market linkage and value chain development for pulses and oilseed through Farmer-Producer Organisations (FPOs) and e-NAM platforms are essential interventions for diversification. Reducing crop concentration and encouraging balanced diversification can improve soil health, optimise resource use, and enhance farmers' resilience to climate and market risks, which contributes to long-term agricultural sustainability in the district. The study highlights the importance of integrating spatial indicators like CCI and CDI into agricultural sustainability assessments to support evidence-based agricultural policymaking in Kaimur and similar regions.

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